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Effect of Micronutrient Seed Treatments on Nutrient Uptake by *Bt* Cotton in Vertisol

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Abstract

The present investigation was carried out during the year June 2017 to January 2018 at Department of Soil Science and Agricultural Chemistry, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India to study the effect of nutrient seed treatments on nutrient uptake, quality of *Bt* cotton and soil nutrient dynamics in vertisol. The field experiment was undertaken in a Randomized Block Design with nine treatments and three replications. The nutrient seed dressing treatments are absolute control, 100% NPK+Zinc Sulphate ($ZnSo_4$), 100% NPK+Zn EDTA, 100% NPK+Borax (B), 100% NPK+Manganese Sulphate ($MnSo_4$), 100% NPK+Sodium Molybdate (NaMo), 100% NPK+Copper Nitrate ($CuNo_3$), 100% NPK+Ferrous Sulphate ($FeSo_4$), 100% NPK+Fe EDTA seed application to *Bt* cotton. The maximum N, P, K, Fe, Mn, Zn, Cu, B and Mo uptake was recorded in the treatment 100 % NPK+Zn EDTA followed by 100% NPK+Fe EDTA treatment. In case of Mo uptake, the treatment 100 % NPK+Zn EDTA was significantly superior overall treatments except treatment 100% NPK+Fe EDTA and 100% NPK+Sodium Molybdate (NaMo). The minimum N, P, K, Fe, Mn, Zn, Cu, B and Mo uptake was recorded in the treatment Absolute control+100% NPK.

Keywords: *Bt* cotton, micronutrients, NPK, nutrient uptake, seed treatments

1. Introduction

Cotton (*Gossypium spp* L.) is one of the most important commercial cash crop and important fiber crop of global significance cultivated in more than 70 countries. It is an important raw material of economy in terms of both employment generation and foreign exchange and hence it is known as 'White gold' or 'friendly fiber and king of fiber'. The cotton plant belongs to the genus *Gossypium* of the family *Malvaceae.* Cotton is one of the principle crops of India, and plays a vital role in the country's economic growth by providing substantial employment and making significant contributions to export earnings (Shivagaje et al., 2004).

Essential micronutrients like Zinc, Iron, Manganese, Copper, Boron and Magnesium plays an important role in physiology of cotton crop and these are being a part of enzyme system or catalyst in enzymatic reactions (Radhika et al., 2013). They are required for plant activities such as respiration, meristematic development, chlorophyll formation, photosynthesis, energy system, protein and oil synthesis, gossypol, tannin and phenolic compounds development (Radhika et al., 2013). Certain micronutrients may help to secure uniform emergence, rapid seedling growth and healthy plant stand (Radhika et al., 2013). Some beneficial effects on seed yield and quality as reflected in viability may be achieved by applying micronutrients (Radhika et al., 2013).

Among the various seed treatments, seed priming is an innovative method (Farooq et al., 2006). In seed priming, seeds are partially hydrated to allow metabolic events to occur without actual germination, and then re-dried (near to their original weight) (Bradford, 1986). Such seeds germinate faster than non-primed seeds (Farooq et al., 2006). Seed priming is employed for better crop stand and higher yields in a range of crops (Singh, 2007). In micronutrient seed priming (nutripriming), micronutrients are used as osmotica (Imran et al., 2004; Singh, 2007). Primed seeds usually have better and more synchronized germination (Farooq et al., 2009) owing simply to less imbibitions time (Brocklehurst and Dearman, 2008; McDonald, 2000; Taylor et al., 1998) and build-up of germination-enhancing metabolites (Basra et al., 2005; Farooq et al., 2006). Several reports indicated the potential of nutripriming in improving wheat yields (Marcar and Graham, 1986; Wilhelm et al., 1988), rice (Peeran and Natanasabapathy, 1980) and forage legumes (Sherrell, 1984). However, one report suggests seed damage and germination inhibition by priming at higher nutrient concentrations (Roberts, 1948).

Marathwada soils supporting cotton cultivation are suffering from macro and micronutrient deficiencies (Patil, 2013). Patil (2013) reported that N, P, K, Zn, Cu, Mn and Fe deficiencies are prevailed in the region to the extent of 100.00%, 89.0%, 86.0%, 15.0%, 12.00% and 42.00% respectively (Patil, 2013). Among the nutrients, macronutrients can be applied to soil with ease owing to its large quantity (Savitri et al., 1999). However because of low application quantity at high cost, cotton growers are reluctant to apply the micronutrients through soil (Savitri et al., 1999). Further it is not easy to spread the small quantity of fertilizers evenly on the soil surface (Savitri et al., 1999).

Under this context and situation seed priming provides an effective and easy alternative for micronutrient application (Savithri et al., 1999; Johnson et al., 2005). Small amount of nutrient is required for seed priming hence can be an economical approach as compared with other methods (Khajeh-Hosseini et al., 2003; Sadeghian and Yavari, 2000). It is observed that under the jurisdiction of four SAU'S of Maharashtra the research on this aspect is very limited, scanty and strewed. Keeping above facts in mind it was thought to study the effect of nutrient seed treatments on nutrient uptake by *Bt* cotton.

2. Materials and Methods

A field experiment was conducted during *kharif* season (June 2017 to January 2018), with *Bt* cotton (*Gossypium hirsutum*) used as a test crop, in the farm of department of Soil Science and Agricultural Chemistry at College of Agriculture, VNMKV, Parbhani (Maharashtra), India situated at 90°16 latitude and 76^0 47 longitude with an elevation of 423.46 M (MSL).

The initial soil pH was 8.12, EC-0.10 dSm^{-1}, Organic Carbon-6.70 g kg^{-1}, Calcium carbonate - 48 g kg^{-1}, available nitrogen-112 kg ha^{-1}, Phosphorus -13.46 kg ha^{-1}, Potassium- 575 kg ha^{-1}. The initial micronutrient status was DTPA Copper-4.*37* mg kg^{-1}, Mangnease-12.04 mg kg^{-1}, Zinc-0.57 mg kg^{-1} and Ferrous-2.62 mg kg^{-1}. The soil was clayey in texture, moderately alkaline in reaction, medium in available nitrogen, phosphorus and sufficient in available potassium and low in sulphur and iron.

The field experiment was carried out on *Bt* cotton (*Gossypium hirsutum*) in *kharif* season during year 2017–18. After completion of preparatory tillage operations, the experiment was laid out in randomized block design comprising (09) treatments and replicated (03) times.

2.1. Treatments details

Nine treatments were formulated to evaluate the studies on effect of seed treatments on growth, yield and quality and soil nutrient dynamics of *Bt* cotton in vertisol. Details of treatment are as follows in table 1.

Table 1: Treatment details

T_1: Ac	Absolute control 100% NPK	
T_2: RZn	100% NPK+zinc sulphate ($ZnSO_4$)	3 g kg^{-1} seed
T_3: RZnE	100% NPK+Zn EDTA	3 g kg^{-1} seed
T_4: RB	100% NPK+Borax (B)	3 g kg^{-1} seed
T_5: RMn	100% NPK+Manganese sulphate ($MnSO_4$)	3 g kg^{-1} seed
T_6: RMo	100% NPK+sodium molybdate (NaMo)	3 g kg^{-1} seed
T_7: RCu	100% NPK+Cupper nitrate ($CuNO_3$)	3 g kg^{-1} seed
T_8: RFe	100% NPK+Ferrous sulphate ($FeSO_4$)	3 g kg^{-1} seed
T_9: RFeE	100% NPK+Fe EDTA	3 g kg^{-1} seed

2.2. Statistical analysis

The results obtained were statistically analyzed and appropriately interpreted as per the method described in "Statistical Methods for Agricultural Workers" by Panse and Sukhatme (1985). Appropriate Standard Error (S.E.) and critical differences (C.D.) at 5% level were worked out for treatment comparison.

3. Results and Dissuasion

3.1. Effect of various nutrient seed dressing treatments with micronutrients on uptake of nutrients by plant of a Bt cotton.

3.1.1. N, P, K uptake

The results pertaining to N, P, K uptake by cotton plant as influenced by various nutrient seed dressing treatment with micronutrients are given in Table 2.

The Nitrogen uptake by cotton stalk varied from 25.91–39.16 kg ha^{-1}. The maximum Nitrogen uptake was recorded with T_3-100% NPK+Zn EDTA followed by T_9 treatment 100% NPK+Fe EDTA during the year of experimentation. The treatment T_1-absolute control recorded lowest plant nutrient uptake as compared to rest of the treatments. The uptake of Nitrogen was significantly higher with all treatments receiving 100% NPK+Zn EDTA seed application.

The range of phosphorus uptake was 6.51–10.19 kg ha^{-1}. The highest phosphorus uptake was recorded in the treatment T_3- 100% NPK+Zn EDTA followed by T_9 treatment 100% NPK+Fe EDTA during the year of experimentation. The lowest phosphorus uptake was recorded in the treatment T_1 absolute control. The phosphorus uptake was significantly higher with all treatments in treatment T_3. Similar results were showed by Farooq et al. (2012).

The potassium uptake was in the range of 26.17–40.53 kg ha^{-1} The maximum potassium uptake was recorded in the treatment T_3-100% NPK+Zn EDTA followed by T_9 treatment

Table 2: Effect of various nutrient seed dressing treatments with micronutrients on N, P, and P uptake of nutrients (kg ha^{-1}) by plant at harvesting stage of a *Bt* cotton

Treatment code	Treatments	Nitrogen uptake	Phosphorus uptake	Potassium uptake
T_1: Ac	Absolute control 100% NPK	25.91	6.51	26.17
T_2: RZn	100% NPK+Zinc Sulphate ($ZnSo_4$)	31.92	8.59	32.52
T_3: RZnE	100% NPK+Zn EDTA	39.16	10.19	40.53
T_4: RB	100% NPK+Borax (B)	29.21	7.37	28.93
T_5: RMn	100% NPK+Manganese Sulphate ($MnSo_4$)	29.46	7.18	28.63
T_6: RMo	100% NPK+Sodium Molybdate (NaMo)	29.67	4.45	28.55
T_7: RCu	100% NPK+Copper Nitrate (CuNo3)	29.80	7.47	29.51
T_8: RFe	100% NPK+Ferrous Sulphate ($FeSo_4$)	30.60	7.92	30.88
T_9: RFeE	100% NPK+Fe EDTA	35.85	9.46	37.16
Grand mean		31.28	7.68	31.20
SEm±		1.51	1.02	2.07
CD (p=0.05)		4.55	3.07	6.24

100% NPK+Fe EDTA and minimum potassium uptake was in the T_1 absolute control. The treatment T_3 was significantly superior over all treatments expect treatment T_9.

3.1.2. Fe, Mn, Zn uptake

The data on uptake of Iron by cotton as affected by various nutrient seed dressing treatments with micronutrients are narrated in the Table 3.

The data indicated that the Fe uptake was significantly higher in the treatment T_3 i.e. 100% NPK+Zn EDTA followed by the treatment T_9-100% NPK+Fe EDTA. Among all these treatments T_3 was significantly higher over all other treatments. The Fe uptake was varied from 586.28–835.52 g ha^{-1}.

The Mn uptake was in the range of 155.00–273.71 g ha^{-1}. The data presented that the Mn uptake was significantly higher in the treatment T_3- 100% NPK+Zn EDTA followed by the treatment T_9- 100% NPK+Fe EDTA and lower was in the treatment T_1- absolute control. Among all these treatments T_3 was significantly superior over all other treatments.

Table 3: Effect of various nutrient seed dressing treatments with micronutrients on Fe, Mn and Zn uptake (g ha^{-1}) of nutrients by plant at harvesting stage of a *Bt* cotton

Treatment code	Treatments	Iron uptake	Manganese uptake	Zinc uptake
T_1: Ac	Absolute control 100% NPK	586.28	155.00	93.27
T_2: RZn	100% NPK+Zinc Sulphate ($ZnSo_4$)	719.65	205.72	122.33
T_3: RZnE	100% NPK+Zn EDTA	835.52	273.71	142.03
T_4: RB	100% NPK+Borax (B)	659.61	190.91	118.53
T_5: RMn	100% NPK+Manganese Sulphate ($MnSo_4$)	656.68	223.71	107.47
T_6: RMo	100% NPK+Sodium Molybdate (NaMo)	664.91	177.60	105.70
T_7: RCu	100% NPK+Copper Nitrate (CuNo3)	670.89	177.90	108.10
T_8: RFe	100% NPK+Ferrous Sulphate ($FeSo_4$)	719.06	195.62	112.68
T_9: RFeE	100% NPK+Fe EDTA	815.51	241.94	126.41
Grand mean		703.51	204.67	115.15
SEm±		37.60	10.86	7.07
CD (p=0.05)		113.20	32.69	21.31

The range of Zn uptake was 93.27–142.03 g kg^{-1} .The maximum was recorded in the treatment T_3-100% NPK+Zn EDTA followed by the treatment T_9-100% NPK+FeEDTA and lower was in the treatment T_1-absolute control. The treatment T_3 was significantly higher among all other treatments. Similar observations were showed by Farooq et al. (2012).

3.1.3. Cu, B, Mo uptake

The Cu uptakes significantly influenced by various nutrient seed dressing treatments with micronutrients are narrated in the Table 4.

The range of Cu uptake was 41.21–71.82 g ha^{-1}. The treatment T_3-100% NPK+Zn EDTA was significantly higher over all treatments and lower was in the treatment i.e. T_1 absolute control. The maximum uptake of Cu was recorded in the treatment T_3 at par with the treatment T_9.

The Boron uptake was in the range of 22.62–40.05 g ha^{-1}. The treatment T_3-100% NPK+Zn EDTA was significantly superior over all treatments and lower was in the treatment T_1-absolute control. The treatment T_3 was significantly superior over all treatments expect treatment T_9.

The range of Mo uptake was 0.55–1.92. The treatment T_3-100% NPK+Zn EDTA was significantly superior over all treatments and lower was in the treatment T_1- absolute control. The treatment T_3 was significantly superior over all treatments expect treatment T_9 and T_6.

Table 4: Effect of various nutrient seed dressing treatments with micronutrients on Cu, B and Mo uptake (g ha^{-1}) of nutrients by plant at harvesting stage of a *Bt* cotton

Treatment code	Treatments	Copper uptake	Boron uptake	Molybdenum uptake
T_1: Ac	Absolute control 100% NPK	41.21	22.62	0.55
T_2: RZn	100% NPK+Zinc Sulphate ($ZnSo_4$)	52.95	33.86	1.33
T_3: RZnE	100% NPK+Zn EDTA	71.82	40.05	1.92
T_4: RB	100% NPK+Borax (B)	54.78	32.64	0.97
T_5: RMn	100% NPK+Manganese Sulphate ($MnSo_4$)	54.50	26.43	1.16
T_6: RMo	100% NPK+Sodium Molybdate (NaMo)	49.09	25.58	1.65
T_7: RCu	100% NPK+Copper Nitrate (CuNo3)	49.06	24.75	1.04
T_8: RFe	100% NPK+Ferrous Sulphate ($FeSo_4$)	57.48	27.64	1.11
T_9: RFeE	100% NPK+Fe EDTA	60.40	37.79	1.51
Grand mean		54.58	30.15	1.24
SEm±		3.12	2.43	0.23
CD (p=0.05)		9.41	7.31	0.69

4. Conclusion

Maximum N, P, K, Fe, Mn, Zn, Cu, B and Mo uptake was recorded in the treatment T_3-100% NPK+Zn EDTA followed by T_9 treatment. In case of Mo uptake, the treatment T_3 was significantly superior overall treatments except treatment T_9 & T_6. The minimum N, P, K, Fe, Mn, Zn, Cu, B & Mo uptake was recorded in the treatment T_1-Absolute control+100% NPK.

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